

Comments to the second draft revision of the consensus document on the bi- ology of wheat (*Triticum aestivum* L.)

Advisory memorandum from DCA – Danish Centre for Food and Agriculture

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Data sheet

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Background

This delivery is prepared on request by the Ministry of Environment and Food, Denmark received 21th of February 2022 by DCA – Danish Centre For Food and Agriculture, Aarhus University. It is part of the "Framework agreement on the provision of research-based policy support to the Ministry of Environment and Food of Denmark and its agencies 2020-2023"

The second draft of the revised Consensus Document on the Biology of Wheat (*Triticum aestivum* L.) [ENV/JM/BIO(2020)6REV1] was prepared by an ad hoc drafting group under the OECD Working Group on Harmonisation of Regulatory Oversight in Biotechnology (WG-HROB). It was sent to AU for comments. AU also provided commentary to the first draft in February 2020.

Comments by DCA, Aarhus University

With reference to our comments to the first draft, we see some improvements but the draft would have benefited from a more thorough revision. We still find that choice and priority of topics could be improved. Of the remaining issues, we would like to emphasize:

- 1) As mentioned in paragraph 29, the largest producer of wheat is the European Union and other major producers include the US, Canada, Russia and Ukraine. However, practices for these high rainfall bread wheat ecosystems known from Eurasia and eastern USA (winter-type wheat) as well as low-moderate rainfall bread wheat ecosystems known from Canada, Finland and northern Asia (spring-type wheat) is sparsely covered and this represent a critical shortcoming of the document. We find that this topic warrants a section of its own because it falls outside the covered categories of irrigated and dryland farming.
- 2) Annex B provide a good but short overview of wheat biotechnology including genetic transformation and genome editing technologies. In the first draft, these topics were barely covered. However, we do not see the rationale for placing this in an annex. Including these major research directions on equal footing in the main text would provide a more balanced and contemporary picture of the wheat research landscape.
- 3) The outline and prioritization of the text could be improved. Section 4, Hybridisation and introgression fall naturally under the topic of section 3. Merging these sections might help resolve the problem with repetition (for instance, section 3.5 and 4.2.1 cover essentially the same topic). In general we find that section 4 is quite comprehensive in comparison to other topics of equal importance.
- 4) Section 3.1.2 need to be updated to include the latest developments in wheat genomics, see (Montenegro *et al.*, 2017; Walkowiak *et al.*, 2020). Maybe its better not to mention specifically how many cultivars have been sequenced since this number may rapidly increase. The modern techniques discussed in section 3.4 deserve more emphasis and should include e.g. TILLING. This would help align the paper better with current research and breeding focus areas.
- 5) Paragraph 88 mention the loss of genetic diversity resulting from modern breeding. It would also be worth mentioning the genetic bottlenecks associated with domestication and the two polyploidization events that happened during the evolution of wheat, see e.g. (Zhou *et al.*, 2020).
- 6) Paragraph 92 briefly mention hybrid wheat, understood as the use of F1 hybrids in the production in order to exploit heterosis. The reader is directed to section 4 for further detail. However, we do not find that section 4 cover this specific topic. It only covers hybridisation in a breeding context. It would be good provide more detail on hybrid wheat in section 3 because this approach has been very successful in other cereals such as maize and even rye. The authors might refer to e.g. (Whitford *et al.*, 2013).
- 7) Section 3 and 4 are inconsistent in spelling homoeologous/ homeologous. We believe the first spelling as used in section 4 to be correct.
- 8) Section 1 has received little if any revision since the first draft. It remains problematic that resent primary literature is inadequately cited, especially publications in the field of genomics. We gave some suggestions in our comments for the first draft:
 - a. Par. 4 A better reference here would be (Marcussen *et al.*, 2014).
 - b. Par. 10 A better reference here would be (Heun *et al.*, 1997).
 - c. Table 1.2 Cultivated einkorn is also found in Transcaucasia. See e.g. (Zaharieva and Monneveux, 2014). The cultivation of einkorn in Transcaucasia was a prerequisite for the hybridization with led to *T. zhukowskyi* so it has some relevance for wheat evolution. Wild timophevii could be written .subsp. *armeniicum* (syn. *T. araraticum*).

- d. Par. 14 Consider including (Kilian *et al.*, 2006) in the references. This paper provides good evidence to support that *Ae. speltoides* is the closest living relative of the B and G genomes.
- e. Par. 17 flag leaf?
- f. Par. 19. This paragraph seem to confuse milling and anatomical terminologies. Actually, the aleurone belong to the endosperm which consist of the aleurone and the starchy endosperm. See e.g. (Evers and Millar, 2002). The size range given for wheat grains seems very narrow.
- g. Table 1.3. The table could also include the distinction between red and white wheat.
- h. Par. 24. Wheat straw is also used as a fuel for heat and electricity in some countries.
- i. Par 26. Hydrolysis of wheat starch yield glucose and maltose (rather than sucrose). Consider a more appropriate reference.
- j. Figure 1.3. This figure needs a more explanatory legend. The map show the average regional output (kg/ha) and not necessarily the major regional production.

In conclusion

The Consensus Document provide an overview of wheat biology including biological and technical aspects of wheat breeding. We find that it fails to adequately cover cultivation practices in major wheat regions across North-, Central- and Eastern Europe as well as parts of North America. The sections on wheat genetic improvement has a very strong emphasis on classic techniques and thus fail to adequately cover developments from the past twenty five years. It would be helpful to elevate annex B to section status and expand section 3.5 in order to future-proof the document.

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